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Vegetation ecology of the southern Free State: Vegetation of the drainage channels

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Little information is available on the vegetation of the southern Free State. A phytosociological analysis of the riparian shrub communities of the southern Free State is presented. Relevés were compiled in 38 stratified random sample plots. A TWINSPAN classification, refined by Braun-Blanquet Procedures, resulted in 9 distinct vegetation units grouped as two major communities.

Introduction

The necessity of detailed plant ecological studies as a basis for sound land-use planning, management and research is widely recognised (Pentz 1938, Codd 1949, Bayer 1970, Foran *et al.* 1986, Bosch *et al.* 1987). One of the major projects in this respect is the Grassland Biome Project. The Grassland Biome of South Africa covers approximately 27% of the country (Rutherford and Westfall 1994). As a result of intensive agricultural practices and urbanisation, together with industrialisation, the deterioration of the grassland led to concern amongst decision-makers, resulting in the launch of the Grassland Biome Project (Mentis and Huntley 1982).

One of the first priorities of this project is to determine the location and extent of the major vegetation types within the Biome (Mentis and Huntley 1982). Description of the plant communities of the Zastron Area (Malan *et al.* 1999), those associated with the rocky outcrops of the dry south-western Free State (Malan *et al.* 1998) and *Acacia* communities (Malan *et al.* 2000, submitted), all form a broad spectrum of the vegetation of the southern Free State.

According to Du Preez (1991) the *Acacietea karoo* in the southern and eastern Free State represents the thickets usually situated on well-developed levees along rivers, streams and drainage lines, and is also present on clayey soils on the low level terraces and flood plains adjacent to rivers. Vegetation of this class may also be found on deep alluvial or colluvial soils on gradual soils on gradual footslopes of hills and ridges, usually situated near drainage lines and rivers (Bredenkamp *et al.* 1989, Bredenkamp and Bezuidenhout 1990). The *Acacia karoo-Rhigozum trichotomum* Community associated with higher-lying areas is discussed elsewhere (Malan *et al.* 2000, submitted).

The aim of this study was therefore to classify and describe the shrub communities in the southern Free State. This report primarily deals with shrub communities associated with low-lying drainage channels and other relevant bottomland habitats. This study also fits in with a comprehensive phytosociological programme under the Grassland Biome Project (Mentis and Huntley 1982, Scheepers 1987).

Study area

The present study includes the southern Free State and is situated to the south of the 29°00'S latitude and to the west of the 27°00' E longitude, encompassing approximately 27 000km².

Two biomes can be distinguished in the study area, namely the Grassland and Nama-Karoo Biomes (Rutherford and Westfall 1994). According to Acocks (1988) the vegetation of these biomes in the southern Free State is divided into six different veld types. Towns situated in the study area are (from north to south) Bloemfontein, Petrusburg, Fauresmith, Wepener, Zastron and Bethulie (Figure 1). According to Low and Rebelo (1996), the grasslands of the Grassland Biome are dominated by a single layer of grasses. Trees are absent, except in a few localised habitats (Low and Rebelo 1996). The Nama-Karoo mainly consists of grassy, dwarf shrubland (Low and Rebelo 1996).

The rainfall is erratic, especially in the western part of the study area from where it increases in an easterly direction from a 300-400mm/annum rainfall interval to a 600-800mm/annum rainfall interval. Slow-draining streams are common owing to the flatness of the terrain.

The habitat is fairly unstable, due to seasonal flooding and drying that, together with the frequent overgrazing of the area, have caused an advanced state of degradation of the vegetation. The soil is often severely eroded and the vegetation obviously disturbed. A detailed description of the study

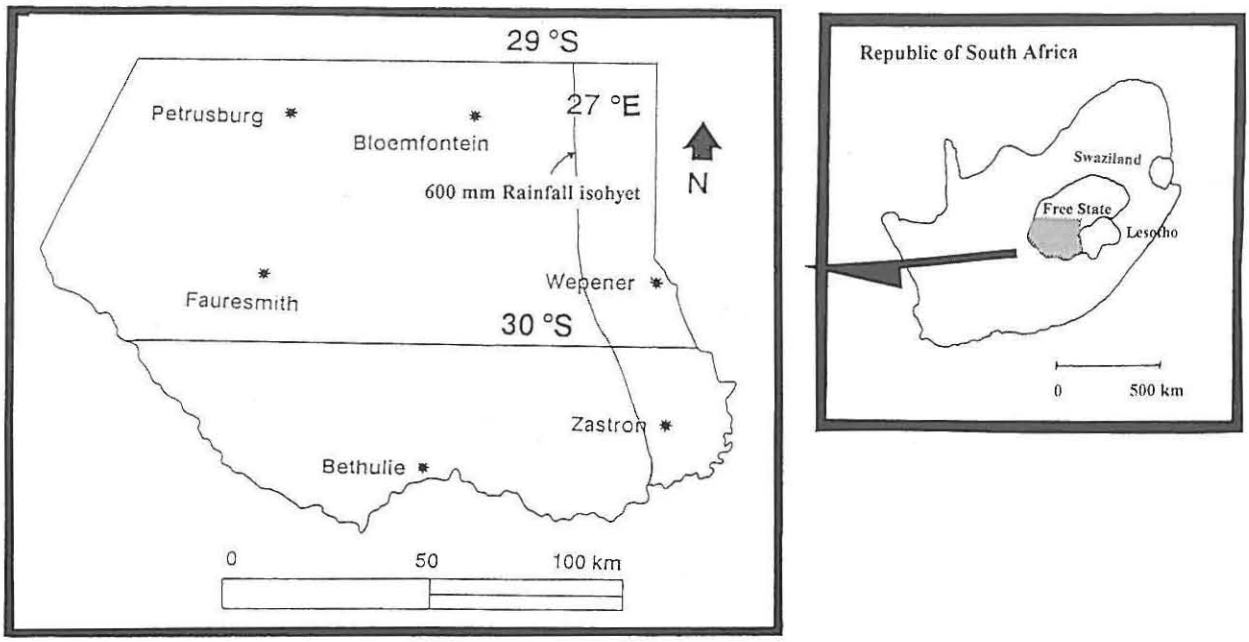

Figure 1: The location of the study area in relation to towns

area and environmental attributes is given elsewhere (Malan *et al.* 1998).

Methods

Relevés were compiled in 38 stratified random sample plots. Care was taken to avoid sampling of severely degraded vegetation and excessively disturbed areas.

Plot size was fixed at 100m² which is in accordance with the plot size used by Scheepers (1975), Bredenkamp and Theron (1978), Rossouw (1983), Van Wyk (1983), Müller (1986), Du Preez (1991), Bezuidenhout (1993) and Fuls (1993). For every plant species present in the sample plot, a cover-abundance value was estimated according to the Braun-Blanquet scale (Mueller-Dombois and Ellenberg 1974).

Two-way indicator species analysis (TWINSPAN; Hill 1979b) was applied to the floristic data set in order to derive a first approximation of the plant communities of the area. In order to determine vegetation gradients and the relationship with environmental variables, Detrended Correspondence Analysis (DECORANA, Hill 1979a) was applied to the floristic data set. Additional data such as soil forms and the rockiness of the soil surface were also noted.

Taxon and author names comply with those of Arnold and De Wet (1993).

Results and Discussion

In the analysis of the vegetation, nine distinct vegetation units were identified. Two major communities, grouped into five distinct plant communities were identified. *Acacia karroo* and *Rhus lancea* respectively dominate these major communities. The communities are classified as follows:

1 *Acacia karroo-Protasparagus laricinus* Major Community
1.1 *Acacia karroo-Salix babylonica* Community
1.2 *Ziziphus mucronata-Protasparagus laricinus* Community
1.2.1 *Rhus pyroides-Lycium hirsutum* Sub-community
1.2.1.1 *Setaria verticillata-Chenopodium* album Variant
1.2.1.2 *Crassula lanceolata-Acacia karroo* Variant
1.2.1.3 *Rhus pyroides-Protasparagus laricinus* Variant
1.2.2 *Heteromorpha trifoliata-Nidorella resedifolia* Sub-Community

2 *Rhus lancea-Rhus burchellii* Major Community
2.1 *Olea europaea-Rhus lancea* Community
2.2 *Rhus erosa-Rhus lancea* Community
2.2.1 *Diospyros austro-africana-Rhus lancea* Sub-community
2.2.2 *Heteropogon contortus-Rhus lancea* Sub-community
2.3 *Euclea crispa-Rhus lancea* Community

Description of the communities

1 *Acacia karroo-Protasparagus laricinus* Major Community

This widespread shrub community is mainly associated with the low-lying areas and undulating plains along public roads. According to Carr (1976), *Acacia karroo* is more widely distributed than any other *Acacia* species and occurs in varying

climatic conditions in all provinces of the Republic of South Africa, eastern Botswana, Swaziland and Lesotho. Although *Acacia karroo* is adaptable to a wide variety of conditions and soil forms (Carr 1976), the location of this major-community is restricted to areas where wind-blown sand and gravel eroding from higher-lying areas often cover the soil surface.

The vegetation is characterised by *Acacia karroo* (species group G, Table 1). According to Carr (1976), *A. karroo* was probably the first of the South African acacias to have drawn the attention of early botanists. Other widely spread trees include *Ziziphus mucronata* (species group F), *Olea europaea*, *Diospyros lycioides* (species group H) and *Rhus lancea* (species group M). *Protasparagus laricinus* (species group F) is the only abundant shrub (Table 1). The sedge *Cyperus longus* (species group F) is also common. Graminoids are scarce and are restricted to patchy occurrences of *Setaria verticillata* (species group B), *Eragrostis obtusa* (species group F), *Themeda triandra* and *Sporobolus fimbriatus* (species group M).

An average of 13 species per relevé was recorded for this major community.

Two distinct communities further characterise this major-community (Table 1).

1.1 *Acacia karroo-Salix babylonica* Community

This community represents azonal wetland-like vegetation and is present in depressions or other bottomland situations. These bottomland situations generally have soils with a higher (>50%) clay content than those of upland areas (Land Type Survey Staff, in press). No rocks or large stones are visible on the soil surface. The soil is poorly drained and low-lying areas are inundated for long periods after rains.

Species of species group A (Table 1) characterise this community. The diagnostic woody species are the exotics *Salix babylonica*, *Schinus molle* and *Nicotiana glauca*, the reed *Phragmites australis*, the grass *Tetrachne dregei*, as well as the shrublets *Asclepias fruticosa* and *Melilotus alba* (Table 1). According to Stirton (1978), *Nicotiana glauca* is indigenous in north-western and central Argentina, Paraguay and Bolivia and commonly occurs along public roads in dongas and on river beds. According to Bromilow (1995), it is thought to have been introduced into Namibia in horse fodder during the German occupation. *Phragmites australis* sometimes is heavily grazed by livestock and generally does not exceed one metre in height. *Acacia karroo* (species group G) has an extremely high cover-abundance and completely dominates the vegetation, with *Diospyros lycioides* (species group I) also generally encountered (Table 1).

An average of eight species per relevé was recorded for this community.

1.2 *Ziziphus mucronata-Protasparagus laricinus* Community

This plant community can be found on the relatively well-drained, sandy soils of riverbanks. Also present are places with clayey and calcareous soil. These places are generally poorly drained, with water visible on the surface weeks after good rains. The soil is drier than that of the *Acacia karroo-Salix babylonica* Community. Habitat disturbance due to continuous overgrazing and trampling of livestock occurs.

Species listed in species group F, with *Ziziphus mucronata* and *Celtis africana* the only exclusive diagnostic tree species, differentiated this vegetation unit (Table 1). *Protasparagus laricinus* , *P. suaveolens* and *Lycium cinerium* (species group F) are the most abundant shrubs. The reed, *Cyperus longus*, normally associated with wetlands (Eckhardt *et al.* 1993), the forb *Tagetes minuta* and the climber *Clematis brachiata*, are the only other abundant and differentiating species (species group F, Table 1). Other conspicuous species include the trees, *Acacia karroo* (species group G), *Olea europaea* (species group H), *Diospyros lycioides* (species group I) and *Rhus lancea* (species group P). The height of these trees varies between 4-5metres.

An average of 15 species per relevé, was recorded.

This plant community is divided into two distinct sub-communities (Table 1).

1.2.1 *Rhus pyroides-Lycium hirsutum* Sub-community

This bottomland vegetation occurs on seasonally wet, well-drained sandy soils of riverbeds. The habitat is fairly unstable due to seasonal flooding and drying. Overgrazing of pasture and trampling of livestock frequently occurs.

Species listed in species group D differentiate this sub-community. *Lycium hirsutum* and *Rhus pyroides* (species group D) are the only abundant and differentiating shrubs and *Panicum maximum* the only differentiating grass (Table 1). Other conspicuous trees and shrubs include *Ziziphus mucronata* (species group F), *Acacia karroo* (species group G), *Diospyros lycioides* (species group I) and *Rhus lancea* (species group P) with *Celtis africana* (species group F) and *Olea europaea* (species group H) less abundant (Table 1).

Three distinct variants further characterise this plant community (Table 1).

1.2.1.1 *Setaria verticillata-Chenopodium* album Variant

The *Setaria verticillata-Chenopodium album* Variant occurs in full sun and is restricted to the disturbed and overgrazed zones of dry riverbeds. Duplex soils are prominent. Large trees are absent and the maximum height of tree species does not exceed two metres.

The two diagnostic species are pioneers, which colonise disturbed habitats. They are the grass *Setaria verticillata* and the forb *Chenopodium album* (species group B, Table 1). The absence of *Olea europaea* (species group H) also differentiates this vegetation unit. *Acacia karroo* (species group G) is inconspicuous and has an average height of only 0.3 metres. Conspicuous species include the sedge *Cyperus longus* (species group D), with *Rhus pyroides* (species group D) and *R. lancea* (species group P) small, but numerous. Forbs are inconspicuous and are restricted to *Chenopodium album* (species group B), *Tagetes minuta*, *Artemisia afra* and *Zinnia peruviana* (species group F), as well as the climber *Clematis brachiata* (species group F).

Table 1: Phytosociological table of the drainage channels in the study area

Major Community	1					2			
Community	1.1	1.2				2.1	2.2		2.3
Sub-Community		1.2.1			.2		.1	.2	
Variant		.1	.2	.3					
Relevé Number	111216 999090 678096	4466 9900 4517	5555 2222 0123	5556 2220 4652	226 660 673	5544 9989 2367	3353 6497 8666	4555 5999 1978	55166 98800 46945
Number of species/Relevé	000000 868989	1111 9725	1111 4456	1110 5547	110 138	0000 6579	0000 7659	0000 5897	00000 55835
SPECIES GROUP A									
Salix babylonica	121311								
Asclepias fruticosa	111111								
Tetrachne dregei	R1 1RR								
Melilotis alba	R RRR								
Nicotiana glauca	111 1								
Schinus molle	121						2		
Phragmites australis	13 R								
SPECIES GROUP B									
Setaria verticillata		2341							
Chenopodium album			R122		R				R
SPECIES GROUP C									
Crassula lanceolata			R++1						
Pollichia campestris			RR R	R					R R
SPECIES GROUP D									
Lycium hirsutum		1111	+111	1121					
Rhus pyroides		221R	221	3111		2			
Cyperus longus	3	3211	212	331					
Panicum maximum		2111	+ .1	1121					
SPECIES GROUP E									
Heteromorpha trifoliata					342				
Nidorella resedifolia					111				
SPECIES GROUP F									
Ziziphus mucronata	1	1211	1213	111R	321				
Protasparagus laricinus	2	11R1	122R		221		1		1
Tagetes minuta		11RR	111	1211	1 1				
Clematis brachiata		1R1R	1++1	21	RR	1			
Celtis africana		1111	1222		11				
Protasparagus suaveolens		R	+ 1	1	R1		1		1
Lycium cinereum		R	1 R		R				
Eragrostis obtusa		R		R	1			R	
Artemisia afra		1		1R					R
Zinnia peruviana		1R	R	R		R			
SPECIES GROUP G									
Acacia karroo	555241	11 1	3233	211	21		1		2
SPECIES GROUP H									
Olea europaea			1111	2	R1	1211			2
SPECIES GROUP I									
Diospyros lycioides	222121	12RR	3222	32		1222	12 1		
Diospyros austro africana				1		12R2	411		
SPECIES GROUP J									
Heteropogon contortus								2221	R
Rhigozum obovatum								121	
SPECIES GROUP K									
Rhus ciliata			+		311		1	2121	21
SPECIES GROUP L									
Aristida diffusa						12 2	32	12	
SPECIES GROUP M									
Rhus erosa							3223	2312	
SPECIES GROUP N									
Euclea crispa subsp. ovata							1 1		11122
SPECIES GROUP O									
Themeda triandra				1 1	2	21	2 2	212	2
Sporobolus fimbriatus		2		12		11			12
SPECIES GROUP P									
Rhus lancea	R	221	231	111	R21	5534	213+	5311	5241
Rhus burchellii	1	R 1				11 1	24	1244	11 11

An average of 18 species per relevé was recorded (Table 1).

1.2.1.2 *Crassula lanceolata-Acacia karroo* Variant

This entity is associated with wet riverbeds at the footslopes of dolerite hills. The undergrowth of this vegetation unit occurs in the full shade of the tree canopy. The soil is sandy with fine dolerite stones from upslope (often 200mm deep) visible on the surface. This habitat is wetter than that of the *Setaria verticillata-Chenopodium album* Variant.

This variant is not well developed. *Crassula lanceolata and Pollichia campestris* (species group C) are the only differentiating species. *Acacia karroo* (species group G), the most abundant tree species, generally exceeds three metres in height. *Rhus pyroides* (species group D), *Celtis africana*, *Ziziphus mucronata* (species group F) and *Diospyros lycioides* (species group I) are more abundant here than in the *Setaria verticillata-Chenopodium album* Variant. The presence of *Olea europaea* (species group H) also differentiates this variant from the *Setaria verticillata-Chenopodium album* Variant (Table 1). *Olea europaea* is shrub-like and generally does not exceed two metres in height.

An average of 15 species per relevé was recorded (Table 1).

1.2.1.3 *Rhus pyroides-Protasparagus laricinus* Variant

This vegetation unit also occurs in dry riverbeds with a thick (50-100mm) layer of dolerite gravel, which gives it a rocky appearance, covering the soil surface. The deeper soil layers are clayish and deep (<100mm deep).

Diagnostic species are absent (Table 1). The most abundant woody species are *Rhus pyroides* (species group D) and *Diospyros lycioides* (species group I). *Acacia karroo* (species group G) and *Rhus lancea* (species group P) are, although inconspicuous, the most abundant trees. The sedge *Cyperus longus* (species group D) often forms dense stands. Noteworthy is the absence of *Celtis africana* (species group F) and the scanty occurrence of *Acacia karroo* (species group G) and *Olea europaea* (species group H). Graminoids are scarce and restricted to *Panicum maximum* (species group D), *Themeda triandra* and *Sporobolus fimbriatus* (species group O).

An average of 15 species per relevé was recorded (Table 1).

1.2.2 *Heteromorpha trifoliata-Nidorella resedifolia* Sub-community

This community is restricted to bottomland situations where poorly drained calcareous soils occur. The soil is calcareous-clayey and calcareous stones are visible on its surface. The soil associated with this sub-community were found to be generally more clayey and trampled than those associated with the *Rhus pyroides-Lycium hirsutum* Sub-community.

The vegetation is overgrazed and the shrub *Heteromorpha trifoliata*, generally not higher than two metres, and the forb *Nidorella resedifolia* (species group E)

are diagnostic (Table 1). *Acacia karroo*, generally not exceeding two metres in height, and *Ziziphus mucronata* (2-4 metres high) (species group F) are the most abundant tree species. Other tree species, include *Olea europaea* (species group H) and *Rhus lancea* (species group P), with *R. ciliata* (species group K) the only locally abundant shrub (Table 1). The absence of *Diospyros lycioides* (species group H), also differentiates this sub-community from the *Rhus pyroides-Lycium hirsutum* Sub-community (Table 1).

2 *Rhus lancea-Rhus burchellii* Major Community

The *Rhus lancea-Rhus burchellii* Major Community is chiefly associated with drainage channels at the footslopes of low hills. The habitat is more rocky than that of the *Acacia karroo-Diospyros lycioides* Major Community and shows strong affinities to the vegetation associated with the rocky outcrops in the southern Free State (Malan *et al.* 1998). Big dolerite rocks (>2m in diameter) from upslope often cover more than 50% of the soil surface. The soil surface is often severely eroded and dongas (donga erosion) are conspicuously observable.

Rhus lancea and *R. burchellii* (species group P) are the only widely dispersed woody species. *Rhus burchellii* (species group P) is diagnostic for this vegetation group (Table 1). *Rhus erosa* (species group M) and *R. ciliata* (species group K) have a more restricted distribution (Table 1). *Rhus erosa*, especially, is common to dominant on more arid mountain slopes and hills (Venter and Joubert 1985). Signs of overgrazing are obvious in some cases, with the pioneer species *Aristida diffusa* prominently present (species group L, Table 1). *Themeda triandra* and *Sporobolus fimbriatus* (species group O) are the only other relatively common graminoids (Table 1).

An average of seven species per relevé was recorded (Table 1).

Three communities are distinguishable (Table 1).

2.1 *Olea europaea-Rhus lancea* Community

This vegetation unit is restricted to the drainage channels at the base of rocky hills next to public roads. The aspect is south and south-east. Soil of the Mispah Form is typical of this habitat with surface-rock percentages exceeding 20%. Big dolerite rocks are common, covering 20-50% of the soil surface. The soil is shallow (<100mm deep) and rocky.

Diagnostic species are absent, but the vegetation is rather characterised by the exceptional dominance of *Rhus lancea* (species group P, Table 1). *Olea europaea* (species group H), *Diospyros lycioides* and *D. austro-africana* (species group I) are the only other conspicuous woody species present. *Aristida diffusa* (species group L) and *Rhus burchellii* (species group P) are the only prominent grass and shrub species respectively (Table 1).

An average of seven species per relevé was recorded (Table 1).

2.2 *Rhus erosa-Rhus lancea* Community

The *Rhus erosa-Rhus lancea* Community is also found along the footslopes of rocky hills. The aspects are south and south-west. The soil is well-drained and sandy with exposed rocks covering less than 20% of the soil surface. Fine gravel virtually covers the soil surface, especially in the lower-lying areas.

Rhus erosa (species group M) is very conspicuous and the only differentiating species present (Table 1). *Rhus lancea* (species group P), together with *R. erosa* (species group M) and *R. burchellii* (species group P) often form dense stands, especially in the lower-lying areas (Table 1).

Two sub-communities further differentiate this plant community (Table 1).

2.2.1 *Diospyros austro-africana-Rhus lancea* Sub-community

This sub-community is encountered on well-drained sandy soils of south-west facing slopes where deep dongas are a common phenomenon. Signs of overgrazing are obvious. The soil varies from shallow (<100mm) to deep (>200mm). The soil is less rocky than in the *Heteropogon contortus-Rhus lancea* Sub-community.

This sub-community lacks exclusive diagnostic species (Table 1). *Diospyros lycioides* (species group I) and *Rhus lancea* (species group P) are the most conspicuous tree species present. *Rhus lancea*, here less prominent than in the *Heteropogon contortus-Rhus lancea* Sub-community, generally does not exceed two metres in height. *Rhus erosa* (species group M) and *Diospyros austro-africana* (species group I) are the most prominent shrubs. The absence of *Heteropogon contortus* and *Rhigozum obovatum* (species group J), as well as the presence of *Diospyros lycioides* and *D. austro-africana* (species group I) further differentiate this sub-community from the *Heteropogon contortus-Rhus lancea* Sub-community (Table 1).

2.2.2 *Heteropogon contortus-Rhus lancea* Sub-community

This sub-community is associated with well-drained sandy-rocky soils. The aspect is south. Rock slabs cover 60% of the soil surface. Fine gravel and dolerite stones are visible on the surface, leaving the rock slabs virtually unexposed.

Heteropogon contortus (species group J), absent in the *Diospyros austro-africana-lancea* Sub-community, is the only diagnostic grass present with the shrub *Rhigozum obovatum* (species group J) being the only diagnostic shrub (Table 1). This sub-community lacks species from species group H, which are evident in the *Diospyros austro-africana-Rhus lancea* Sub-community (Table 1). A further characteristic of this vegetation unit is the partial dominance of *Rhus lancea* and *R. burchellii* (species group P) respectively. *Rhus ciliata* (species group K) is widespread and is the only other prominent shrub. The grasses *Themeda triandra* (species group O) and *Aristida diffusa* (species group L) are the only noteworthy graminoids present (Table 1).

2.3 *Euclea crispa-Rhus lancea* Community

The *Euclea crispa-Rhus lancea* Community is restricted to the rocky low-lying drainage channels at the foot of dry

north-facing hill slopes. Big dongas are common with a thick layer of gravel (100-200mm) covering the soil surface. The soil is shallow (<100mm), rocky (>60%) and of the Mispah Form (Land Type Survey Staff, In Press).

The shrub *Euclea crispa* (species group N) differentiates this plant community (Table 1). *Rhus lancea* (species group P) is totally dominant and is the only conspicuous tree present (Table 1). Graminoids are poorly represented and only *Themeda triandra* and *Sporobolus fimbriatus* (species group O) are worth mentioning (Table 1).

Ordination

In the scatter diagram the distribution of syntaxa along the first and second axes of the DECORANA ordination is given (Figure 2). No clear discontinuity exists between the different communities. It was thus decided to restrict the ordination to the two major communities. Clear discontinuity can be observed and the major plant communities are restricted to specific areas in the diagram. The first axis illustrates a gradient that may be related to altitude and rockiness of the soil surface. Plant communities associated with the rocky drainage channels and the footslopes of hills (*Rhus lancea-Rhus burchellii* Major Community) are to the right of the diagram while communities of the lowlands and undulating terrain with less rocky soil (*Acacia karroo-Diospyros lycioides* Major Community) are to the left of the diagram. Along the second axis a moisture gradient exists. Plant communities in wet areas are situated at the top. The moisture decreases towards the bottom with the communities associated with dry habitat situated at the bottom of the diagram (Figure 2).

The distribution pattern of the vegetation of drainage channels apparently depends primarily on the variations in irradiation (Fuls 1993) and rockiness of the soil surface. The hierarchical classification of the vegetation stresses the correlation between habitat and communities in the study area, as well as the relationships between communities.

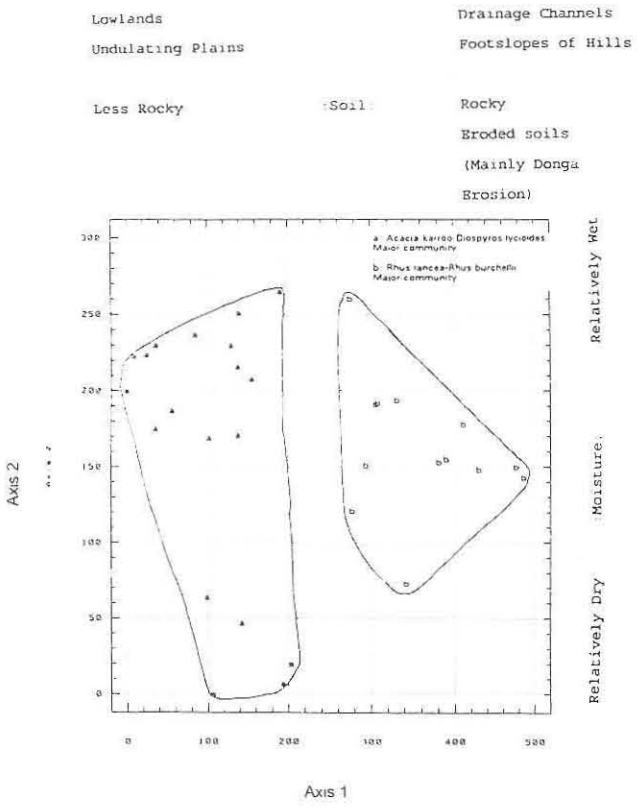

Figure 2: A DCA ordination of the major riparian shrub communities in the southern Free State; (a) *Acacia Karoo-Diospyros lycioides* Major Community; (b) *Rhus lancea-Rhus burchellii* Major Community

Discussion

The vegetation of the drainage channels of the southern Free State is in a state of degradation. All the plant communities identified in this study could be related to specific environmental conditions in the field. It is important to note that, although some of these communities show strong affinities with the vegetation associated with rocky outcrops in the study area (Malan *et al.* 1998), all these communities were encountered in bottomland situations and drainage channels.

Plant communities are dynamic and may display changes in species composition according to the habitat. According to Eckhardt (1993), field in a good condition is usually characterised by a high basal cover of high ecological status species. The low cover of ecological important grasses is further indicative of veld in a poor condition (Van Oudtshoorn 1991). The vegetation associated with drainage channels can therefore be described as field in a poor condition. The most important woody species are *Acacia karroo, Diospyros lycioides, Olea europaea, Protasparagus laricinus, Rhus burchellii, R. ciliata, Rhus lancea* and *Ziziphus mucronata*. *Acacia karroo, Diospyros lycioides* and *Rhus lancea* are the most important differentiating species. *Themeda triandra* and *Sporobolus fimbriatus* are the most abundant grasses. Signs of overgrazing are obvious with the pioneer species *Aristida diffusa* prominently present. Other species commonly occurring in overgrazed areas are *Artemisia afra, Asclepias fruticosa, Chenopodium album, Clematis brachiata, Lycium cinerium, Nidorella resedifolia, Protasparagus suaveolens*, and *Tagetes minuta* (Malan 1997). According to Van Oudtshoorn (1991), *A. diffusa* is an unpalatable grass and can be seen as indicative of overgrazed pasture. *Aristida diffusa* also frequently occurs on rocky outcrops in the southern Free State (Malan *et al.* 1998).

In contrast to the mountainous habitats, the communities associated with drainage channels display generally a lower species diversity. The habitat is fairly unstable, due to seasonal flooding and drying which, together with the frequent overgrazing of the area, play an important role in the degradation of the vegetation. The strong presence of certain woody species within the drainage channels is ascribed to the favourable moisture regimes in these areas. Habitat disturbance (especially in areas along public roads) frequently occurs.

Ross (1948) stated that continuous degradation of natural pasture in many parts of the world is visible. Dense strands of fire resistant mature tree and shrub species supress the

growth of grasses and fire thus its detrimental effect (Trollope 1974). Observations made in the Eastern Cape show that *Acacia karroo* was able to survive eight years in succession by coping after each burn (Trollope 1974).

Ecologically sound conservation management programmes should take this present delineation of the riparian shrub communities as the basis for future management planning. The restricted distribution of these communities emphasises the fact that these areas should be given higher conservation priority.

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